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Abstract

Higher educated people tend to be more accepting of homosexuality than lower educated people. This has inspired claims that education leads to a higher acceptance of homosexuality. Alternatively, the association between education and acceptance of homosexuality could be confounded by (un)observed family background and stable individual characteristics. This study investigated the association between education and acceptance of homosexuality and the role of potential confounders in a unique longitudinal sample of British siblings. Multilevel and fixed effects analyses show that both perspectives apply. A large part of the association between education and acceptance of homosexuality could be attributed to family background and observed individual characteristics (one third), as well as unobserved individual characteristics (an additional third), but the positive association remains. Findings are discussed in light of existing explanations regarding the effect of education on the acceptance of homosexuality.

Keywords: homosexuality; attitudes; education; fixed effects; United Kingdom

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1. Introduction

Recent studies show that on average, levels of acceptance of homosexuality are rising (Andersen & Fetner, 2008; Keleher & Smith, 2012; Slootmaeckers & Lievens, 2014). In a parallel development, many Western countries have adopted egalitarian legislation with regard to same-sex orientations since the late 1990's. It remains unclear however, what mechanisms underlie this relatively swift change in public climate. Some studies attribute an important role to education. There is abundant evidence that lower educated people think more negatively about homosexuality than higher educated people (Andersen & Fetner, 2008; Keleher & Smith, 2012; Van den Akker, Van der Ploeg, & Scheepers, 2013). Higher education is argued to lead to more acceptance of homosexuality, for instance through its stimulation of greater cognitive sophistication and complex reasoning, enabling individuals to better evaluate new ideas (Ohlander, Batalova, & Treas, 2005), or through interaction with progressive fellow students at (higher) education institutions (Campbell & Horowitz, 2016). Explanations of this kind, which claim that education has a causal effect on acceptance of homosexuality, are labelled *educational effects explanations* (Campbell & Horowitz, 2016). Most proponents of educational effects explanations assume the effect of education to be long-lasting, since the large majority of people are in education in their youth and early adulthood. This is believed to be the "formative phase" of life, during which people shape their attitudes, which are believed to change only little thereafter (Inglehart, 2008).

Family background and individual characteristics could confound the proposed effect of education on the acceptance of homosexuality. Parents are generally thought to be of substantial importance for the development of the attitudes of their children (e.g. Jennings, 1984; Lubbers, Jaspers, & Ultee, 2009; Min, Silverstein, & Lendon, 2012; Sabatier & Lannegrand-Willems, 2005). Also, stratification research has for long established the important role of parents for the educational outcomes of children (Blau & Duncan, 1967; Breen & Goldthorpe, 1997; Erikson & Jonsson, 1996; Kallio, Kauppinen, & Erola, 2016). Furthermore, individual characteristics such as aspirations or cognitive ability could influence both educational outcomes (Heckman, Stixrud, & Urzua, 2006; Homel & Ryan, 2014) and acceptance of homosexuality (Ohlander et al., 2005). Previous research may therefore have overestimated the importance of educational attainment for the acceptance of homosexuality.

Such types of explanations, which claim that the association between education and the acceptance of homosexuality is confounded by family background or individual level factors, are labelled *spurious effects explanations* (Campbell & Horowitz, 2016).

In this paper, we put the proclaimed causal effect of education on the acceptance of homosexuality to the test. Educational effects explanations and spurious effects explanations will be used as frameworks for developing opposing hypotheses. Hypotheses are tested by consecutively estimating a series of multi-level, family fixed effects, and individual fixed effects regression models in a large panel sample of siblings. The family fixed effects model compares siblings within a family and thereby controls for all time-constant family background factors that could potentially influence both level of education and acceptance of homosexuality. Similarly, individual fixed effects models examine the effect of within-person changes in education on within-person changes in acceptance of homosexuality. This makes it possible to separate out all (measured and unmeasured) time-constant differences between individuals that could potentially influence both level of education and acceptance of homosexuality (see Allison, 2009). The individual fixed effects model thus forms a stricter test of the educational effects explanation than the family fixed effects model. To our knowledge, no studies have been conducted that tried to separate the effect of education on the acceptance of homosexuality from potential confounding by family background or individual characteristics in such a way. Two studies have tried to isolate the effect of education from family background for other dimensions of socio-political attitudes, by estimating family fixed effects models (Campbell & Horowitz, 2016; Sieben & Graaf, 2004). Findings were mixed. Education was significantly related to post-materialism, civil liberties & gender role attitudes. Yet, family background completely confounded the association between education and religiosity, political party preference, political ideology, and both economic and cultural conservatism. These studies thus provide no clear clue as to whether or not family background confounds the association between education and acceptance of homosexuality.

We used data from the British Household Panel Survey (BHPS), a representative household sample that followed over 10,000 respondents in more than 5,000 households in the United Kingdom from 1991 until 2008 (Taylor, Brice, Buck, & Prentice-Lane, 2010). Acceptance of homosexuality was measured biennially in the BHPS between 1998 and 2008. For the aims of our study we used a subsample of 5,421 siblings from 3,155 families with information on both educational attainment and acceptance of homosexuality.

The design of this study enabled us to put the association between education and acceptance of homosexuality to a number of novel and strong tests. First, information on family background characteristics and parental levels of acceptance of homosexuality were provided by parents themselves. We did not need to rely on proxy reports of parental measures by children, as earlier studies on the effect of family background on acceptance of homosexuality had to (Jaspers, Lubbers, & De Vries, 2008; Lubbers et al., 2009). This enabled us to control for the influence of (measured) family background characteristics in an unbiased manner. Second, we employed a family fixed effects model, which enabled us to isolate the influence of education on acceptance of homosexuality from family background. Third, the longitudinal nature of this study gave us the opportunity to analyze whether within-person changes in educational attainment were related to within-person changes in acceptance of homosexuality. In sum, this study is novel in being able to consecutively examine multilevel, family fixed effects, and individual fixed effects estimates of the effect of education on acceptance of homosexuality. A comparison of these estimates could help in gaining deeper knowledge in the mechanisms underlying this association.

2. Theory and Hypotheses

Research on the acceptance of homosexuality has frequently shown that lower educated people think more negatively about homosexuality than higher educated people (Costa, Bandeira, & Nardi, 2013; Herek, 1988). The evidence comes from a multitude of sources. Studies using large scale nationally representative samples provide consistent evidence of an association between education and acceptance of homosexuality (Andersen & Fetner, 2008; Gerhards, 2010; Keleher & Smith, 2012; Patrick et al., 2013; Van den Akker et al., 2013). Furthermore, assessing multiple waves of General Social Survey data, Loftus (2001) concluded that rising levels of education were for a large part responsible for increasing acceptance of homosexuality in the US over time. Additional support for the claim that education leads to more acceptance of homosexuality comes from studies employing college samples. Lambert and colleagues (2006) compared higher and lower year students and found that students from higher years were more accepting of homosexuality than lower year students. What is more, Lottes & Kurilloff (1994) found that students became more accepting of homosexuality as they progressed through college. This finding refutes the possibility of differences in acceptance between lower and higher year students being a selection effect (i.e.,

that more liberal and accepting students have a higher chance of progressing through to the final stages of college than less accepting students).

2.1. Educational effects models

Research has offered several explanations for the association between education and acceptance of homosexuality. Some of these explanatory models, sometimes labelled "educational effects models", ascribe a causal role to education (Campbell & Horowitz, 2016). A first set of explanations argues that the acceptance of homosexuality comes about via increased levels of 'cognitive sophistication' or 'mobilization', which is stimulated in education. That is, the cognitive development that is stimulated in education is argued to make persons adopt more rational and flexible strategies of reasoning. These strategies are thought to stimulate persons' critical thinking skills and their capacity to evaluate different sides of a complex issue (Lottes & Kuriloff, 1994; Ohlander et al., 2005; Stubager, 2008). As a consequence, traditional concepts, such as the rejection of homosexuality, might be questioned rather than automatically accepted, and people might be better able to evaluate new ideas in a rational and unbiased manner (Dalton, 1984; Ohlander et al., 2005). A related argument puts emphasis on the effect of education on personal security. Here it is argued that education leads people to feel personally more secure and develop a sense of mastership of their own life, which makes them better able to tolerate (sexual) diversity (Weil, 1985).

Others argue that liberal values, such as a positive stance towards homosexuality, are directly socialized to those enrolled in (higher) education (Carvacho et al., 2013; Lambert et al., 2006; Ohlander et al., 2005; Stubager, 2008). The idea is that education does not merely teach cognitive skills, but that teachers and educational institutions also socialize students in a normative sense (Lambert et al., 2006). More specifically, it is believed that (Western) education promotes libertarian values and an enlightened view on human relations in general and on homosexuality in particular, which leads to acceptance of homosexuality (Gaasholt & Togeby, 1995; Jenssen & Engesbak, 1994; Ohlander et al., 2005; Slootmaeckers & Lievens, 2014; Weil, 1985). Ohlander and colleagues (2005), using a cross-sectional design, find evidence for both of the aforementioned mechanisms: they find that the association between education and acceptance of homosexuality was partly mediated by both cognitive sophistication (first set of explanations) and support for civil liberties (second set of explanations).

Lastly, informal interactions and encounters experienced during education could be important. Some argue that through interaction with other (supposedly progressive) students,

as well as through informal interactions with teachers, students adopt the positive attitudes towards homosexuals that these interaction partners hold (Patrick et al., 2013; Stubager, 2008). Others assert that the introduction to a greater diversity of ideas and lifestyles in especially higher education leads students to become more open-minded and challenge their previously established viewpoints (Andersen & Fetner, 2008; Lambert et al., 2006; Lottes & Kuriloff, 1994). Empirical support for this last mechanism in particular comes from research on contact theory, where it has been found that interactions with homosexual individuals lead to a substantial increase in acceptance of homosexuality amongst heterosexual individuals (Pettigrew & Tropp, 2006). In resume, all explanations and evidence reviewed above point to our first hypothesis.

H1: Education leads to more acceptance of homosexuality.

2.2. Spurious effects models

2.2.1. Family background

In contrast to educational effects models, so-called "spurious effects models" argue that the association between education and attitudes is not causal but spurious (Campbell & Horowitz, 2016). These models argue that the link between attitudes and education is confounded by family background (Inglehart, 1985). We suggest a couple of routes through which family background may influence both educational attainment and the acceptance of homosexuality. First, research suggests that being raised in a religious family could make people less accepting of homosexuality, as most religions express a lack of acceptance of homosexuality (Adamczyk & Pitt, 2009; Andersen & Fetner, 2008; Whitley, 2009). Accordingly, religiosity has been found to be associated with lower levels of acceptance of homosexuality (Costa et al., 2013; Whitley, 2009). Differences between religious denominations have been observed as well. Controlling religious service attendance, Muslims and Eastern Orthodox Christians are usually found to be less accepting of homosexuality than people belonging to other religious denominations (Adamczyk & Pitt, 2009; Van den Akker, Van der Ploeg, & Scheepers, 2013). In addition to parental religiosity, parental levels of acceptance of homosexuality could directly influence the levels of acceptance of homosexuality of their children via socializing efforts (Lubbers et al., 2009). Furthermore, having an ethnic minority background could confound the association between education and attitudes, since studies have shown that an ethnic minority background is associated with both lower educational

attainment (Heath, Rothon, & Kilpi, 2008; Modood, 2005) and less acceptance of homosexuality (Davies, 2004; Huijnk, 2014). Similarly, family socio-economic status is a strong predictor of educational attainment (Blau & Duncan, 1967; Conley, 2001), as well as of the attitudes one obtains (e.g., Kingston, Hubbard, Lapp, Schroeder, & Wilson, 2003). As such, some perceive education as an institutional device for the socialization of specific ideologies for social groups. Differences in levels of prejudice as a function of education would then be a manifestation of the ideological configuration of each social class (Carvacho et al., 2013). In accordance with such claims, Davis and Pearce (2007) find that children with more gender-egalitarian attitudes also have higher educational expectations. In a similar vein, some empirical studies suggest that the effect of education on civic participation is spurious, owing to family background (e.g. Schnittker & Behrman, 2012). These findings suggest that the association between education and acceptance of homosexuality might be spurious. This leads to our second hypothesis, which contrasts the previous hypothesis.

H2: The association between education and acceptance of homosexuality is confounded by family background.

2.2.2. Individual level confounders

In sum, differences between families in both acceptance of homosexuality and education may be explained by confounding factors at the family level. One way to deal with this is by comparing the level of education and acceptance of homosexuality of siblings using family fixed effects, as this filters out all (un)measured time-constant family background factors that may confound this association (Allison, 2009; Campbell & Horowitz, 2016; Sieben & Graaf, 2004). Within families, differences between siblings in acceptance of homosexuality could then be the results of one sibling being more or less educated than another sibling. However, controlling for family background does not take into account individual differences between siblings that may predict both acceptance of homosexuality *and* education. For instance, there can be substantial differences between siblings in aspirations and personality (Barni, Roccato, Vieno, & Alfieri, 2014; Kretschmer & Pike, 2010). Both aspirations and personality characteristics have been associated with higher educational attainment (Homel & Ryan, 2014; Poropat, 2009), and a personality trait such as openness to new experiences could conceivably be related to acceptance of homosexuality and higher educational attainment. Furthermore, substantial differences between siblings can exist in conservatism (Barni et al.,

2014), which correlates negatively with acceptance of homosexuality (Costa et al., 2013). Also, siblings can differ substantially in cognitive ability (Conley, Pfeiffer, & Velez, 2007), which has been related to both acceptance of homosexuality (Ohlander et al., 2005) and educational outcomes (Heckman et al., 2006). Lastly, siblings might establish different friendships and peer groups. This could lead to differences in educational achievements and acceptance of homosexuality, as studies on high-school samples have shown that peers can exert a substantial influence on both the academic functioning (Rambaran et al., 2017) and attitude development of adolescents (Caravita, Sijtsema, Rambaran, & Gini, 2014; Van Zalk, Kerr, Van Zalk, & Stattin, 2013).

Studies testing intra-individual change in education and acceptance of homosexuality are scarce. Carvacho et al. (2013) tested the effect of education on acceptance of homosexuality both cross-sectionally and longitudinally, employing several European surveys. Whilst a cross-sectional association between the acceptance of homosexuality and education was established, no effect was found of education on acceptance of homosexuality when testing the proposed effect in a cross-lagged path model. This suggests that the association between education and acceptance of homosexuality is confounded by individual characteristics.

All in all, individual characteristics/differences between siblings not controlled for in a sibling comparison could be important confounders of the association between education and acceptance of homosexuality. We test this expectation in our last hypothesis.

H3: The association between education and acceptance of homosexuality is confounded by individual characteristics.

3. Data and methods

3.1. Data

We tested our hypotheses using the British Household Panel Survey (BHPS). The BHPS is a longitudinal panel survey of private households, representative of the United Kingdom. Data were collected annually from 1991 to 2008 (Taylor et al., 2010). A stratified-multistage-sampling-design was used, with individuals clustered in households and areas of residence (Astell-Burt, Mitchell, & Hartig, 2014). All household members of 16+ years[1] were eligible

[1] Some respondents were fifteen when first interviewed.

for interview. The BHPS has the advantage that information on all household members was derived from personal interviews and not by proxy reports. For the purpose of this study we used a subsample of the BHPS, extracting from the original sample all families with children. Data was structured to follow the (adult) child over a period of up to ten years, as the BHPS measured the acceptance of homosexuality every two years in six of the total of eighteen waves (in 1998, 2000, 2002, 2004, 2006 and 2008).

We selected all families with (adult) children that were present in 1998 or entered the study between 2000 and 2008 ($N_{families}$= 4,082, $N_{individuals}$= 6,496, $N_{observations}$ =20,445). Out of this sample, we selected families with at least one interviewed parental figure ($N_{families}$= 3,661, $N_{individuals}$= 6,083, $N_{observations}$ = 18,571). A minority of these families only contained children in middle or late adulthood. People in middle and late adulthood probably show very little variation in education and acceptance of homosexuality over the course of the study, making them of little use in an individual fixed effects regression model. Therefore, we selected families in which the oldest "child" was at most forty years of age in 2008. This resulted in a final analytical sample of 16,088 observations of 5,421 individuals (the children) from 3,155 families.

In order to prevent loss of data and potential bias due to missing information on some of the study variables (listwise deletion would have led to $N_{families}$= 2,715; $N_{individuals}$= 4,512; $N_{observations}$ = 14,088), we employed multiple imputation using chained equations (White, Royston, & Wood, 2011). Twenty imputed datasets were created. The dependent variable was included in the imputation model, as is generally advised by both proponents and opponents of the usage of cases with missing data on the dependent variable within multiple imputation procedures (von Hippel, 2007). We used standard MI procedures, retaining the cases with missing information on the dependent variable during the estimation process. Results were almost identical when we used MID instead (deleting those observations with missings on the dependent variable before the estimation process) (von Hippel, 2007).

3.2. Measures

Acceptance of homosexuality was measured biennially using one Likert-type statement, reading: "Homosexual relationships are wrong." Answering categories were 1 (strongly agree), 2 (agree), 3 (neither agree, nor disagree), 4 (disagree), 5 (strongly disagree).

Education was measured in each wave using the International Standard Classification of Education, version 1997 (ISCED-97) (OECD, 1999). The following categories were delineated: (1) Left school between the ages of 11 and 14 without obtaining any lower secondary/compulsory education degree (ISCED 1); (2) Left school after the age of 14 without obtaining any lower secondary/compulsory education degree (ISCED 2); (3) Completed secondary education ("first to fifth form") (ISCED 3c); (4) Completed further education ("sixth form") (ISCED 3a); (5) Obtained vocationally oriented higher education qualifications (e.g. National Vocational Qualifications level 4 and 5, BTEC Higher National Certificate, Diploma of Higher Education) (ISCED 5b); (6) Obtained a university bachelor or master degree (ISCED 5a); (7) Obtained a doctorate or equivalent degree (ISCED 6) (Schneider, 2008). Respondents were classified in one of these categories, based on detailed information provided by the participants on their educational qualifications (Taylor et al., 2010).

Period and cohort indicators were included as covariates in order to control for overall changes in acceptance of homosexuality over time (period) and differences in opinion between respondents from different birth cohorts. Age was not included as a covariate, as simultaneous modelling of age, period and cohort indicators is problematic (Bell & Jones, 2014). Ten year birth cohorts were used (additional analyses using five year birth cohorts did not lead to substantially different results).[2]

We furthermore controlled for **gender and religiosity of the child**, as these factors might correlate with both the child's level of education and acceptance of homosexuality. Religiosity was measured by two variables: frequency of religious service attendance and religious denomination. We contrasted a frequency of attendance of once a year or less (only for weddings or funerals; practically never; at least once per year) to a frequency of attendance of at least once per month, or at least once per week. Four religious denominations were distinguished: (1) No religion (2) Christian, (3) Muslim, and (4) Other. "No religion" was the reference category. Religious service attendance and religious denomination were operationalized as time-constant variables, as over 85% of respondents did not report any change in these variables within the study period. Consequently, including time-varying indicators of religiosity did not lead to different conclusions regarding the effect of education (results not shown). We used information from the earliest time-point available.

[2] We additionally checked for period-cohort interactions (expecting that people from younger cohorts showed stronger changes over time); but did not include them as most interaction terms were not significant and did not change the estimated effect of education.

Family background characteristics. We controlled for parental education, religiosity (both religious service attendance and religious denomination), ethnic group membership, and acceptance of homosexuality. A combined measure for parental education was created by using the highest level of education of either parent. A combined measure for parental religious service attendance was created by using the highest level of religious service attendance of either parent. Parents were coded as "Other", Muslim, or Christian respectively, if at least one of both parents identified as such, with non-religious parents being the reference category. A combined measure of parental ethnic group membership was created by coding parents as belonging to an ethnical minority group when at least one of the parents had an ethnic minority background. Respondents were coded as having an ethnic minority background when they indicated to belong to any ethnic group other than "White". This included respondents who indicated to be of mixed "White" and other ethnical background. We used the mean level of acceptance of homosexuality of father and mother. For some respondents, information on family background characteristics of only one parent was available. In those cases, information of that parent was used[3]. Furthermore, all of the family background characteristics were operationalized as time-constant variables. We used information from the earliest time-point available. Note that there was relatively little change over time in parental levels of acceptance of homosexuality. Furthermore, using parental acceptance of homosexuality as a time-varying variable did not change the estimated effects of education (results available upon request).

3.3. Analyses

We present multilevel and fixed effects models to examine the effect of education on acceptance of homosexuality. First, we fitted multilevel models that regressed acceptance of homosexuality on level of education. Variance was partitioned to three levels: observations (1) which were nested within individuals (children) (2), which were nested within families (3). We started off with a baseline model where acceptance of homosexuality was regressed on level of education alone, in order to model the most naive estimate of education on acceptance of homosexuality. In model two we included individual control variables as well as period and cohort indicators. In model three, family background characteristics were added. In the fourth and final multilevel model, we also controlled for parental acceptance of

[3] Additional models measuring family background differently (i.e., using information of either the father or the mother as default), as well as models in which information of fathers and mothers was entered into the model separately did not lead to substantively different results (results available upon request).

homosexuality. We employed sandwich estimators of standard errors in order to assure robustness against heteroscedasticity of the error terms (StataCorp, 2017).

Second, we present two fixed effects models. The influence of family background and individual characteristics can occur through a myriad of ways, so simply controlling for a specific -always limited- set of measured variables may not be sufficient to take their role into account. The multilevel models cannot control for unmeasured confounding variables, which may lead to (upwardly) biased estimates of the effect of education on acceptance of homosexuality. Fixed effects models allow one to control for potential confounding by unmeasured variables, by using each cluster as his or her own control, thereby controlling for all time-constant factors at the cluster-level (Allison, 2009). Consequently, fixed effects regression models estimate how within-cluster variation in the predictor (level of education) co-varies with within-cluster variation in the outcome (acceptance of homosexuality). We first estimated a family fixed effects model, thereby controlling for all time-constant family background factors (both measured and unmeasured) that could potentially influence both level of education and the level of acceptance of homosexuality (Allison, 2009). The effect of education on acceptance of homosexuality in this model can be interpreted as the extent to which differences between siblings (net of differences between families) in education explain differences between siblings in acceptance of homosexuality. Standard errors were clustered by the individual because some individuals were observed multiple times. Fixed effects models are known to have lower statistical power compared to equivalent multilevel models (Allison, 2009). When comparing the estimates of the multilevel and fixed effects regression models, differences were therefore mainly interpreted by looking at discrepancies in parameter estimates, instead of differences in significance.

The family fixed effects model does not account for differences between siblings within the same family that may explain both acceptance of homosexuality and level of education. Therefore, the most conservative test of the effect of education on the acceptance of homosexuality is the individual fixed effects model. The effect of education on acceptance of homosexuality in this model can be interpreted as the extent to which changes in education within individuals over time explain changes in acceptance of homosexuality within individuals over time. Standard errors were clustered by family, in order to control for the fact that siblings were nested within the same family.

The primary analysis treats the effect of education as a linear effect. We also report models with a (potentially) non-linear education effect by operationalizing education as a set of dummy variables. The proportion of respondents that left school after age 14 with no degree (ISCED 2) and the proportion of respondents that obtained a doctorate (ISCED 6) was low, leading to reduced power in especially the fixed effects models. Furthermore, respondents that left school after age 14 with no degree showed little variation in educational attainment over time, making them of little use for the individual fixed effects model. Therefore, respondents that left school after age 14 with no degree were merged with respondents that left school before age 14 with no degree and respondents that obtained a doctorate were merged with respondents that obtained a university bachelor or master. Consequently, we differentiated between five broad educational groups in the dummy analyses: 1) left school without degree (ISCED 1/2); 2) secondary education (ISCED 3c); 3) further education (ISCED 3a); 4) Higher vocational education (ISCED 5b); 5) University degree and higher (ISCED 5a/6).

3.3.1. Alternative analytical samples

The analytical sample included as many observations of families as possible, including families with only one child, and families with children who were only observed once. Families with only one child are not informative for the family fixed effects models and individuals who were only observed once are not informative for the individual fixed effects models (see Allison, 2009). Furthermore, our analytical sample only included children within families, excluding other respondents that potentially show variation in education and acceptance of homosexuality. We therefore reran our models on two different samples. Alternative sample B was a sibling comparison sub-sample that used only families with at least two siblings (Table A.1 and A.2 in the Appendix). Alternative sample C was a sample with a longitudinal focus that consisted of all individuals in the BHPS that provided information on both acceptance of homosexuality and level of education who were at most forty (Table A.3 and A.4). Two tables for each subsample are presented in the Appendix, as we re-estimated models for the alternative samples using education both as a linear construct and as a series of dummy variables. An overview of all the sample selection steps and consequent sample sizes for the analytical sample and both alternative samples can be found in Figure 1.

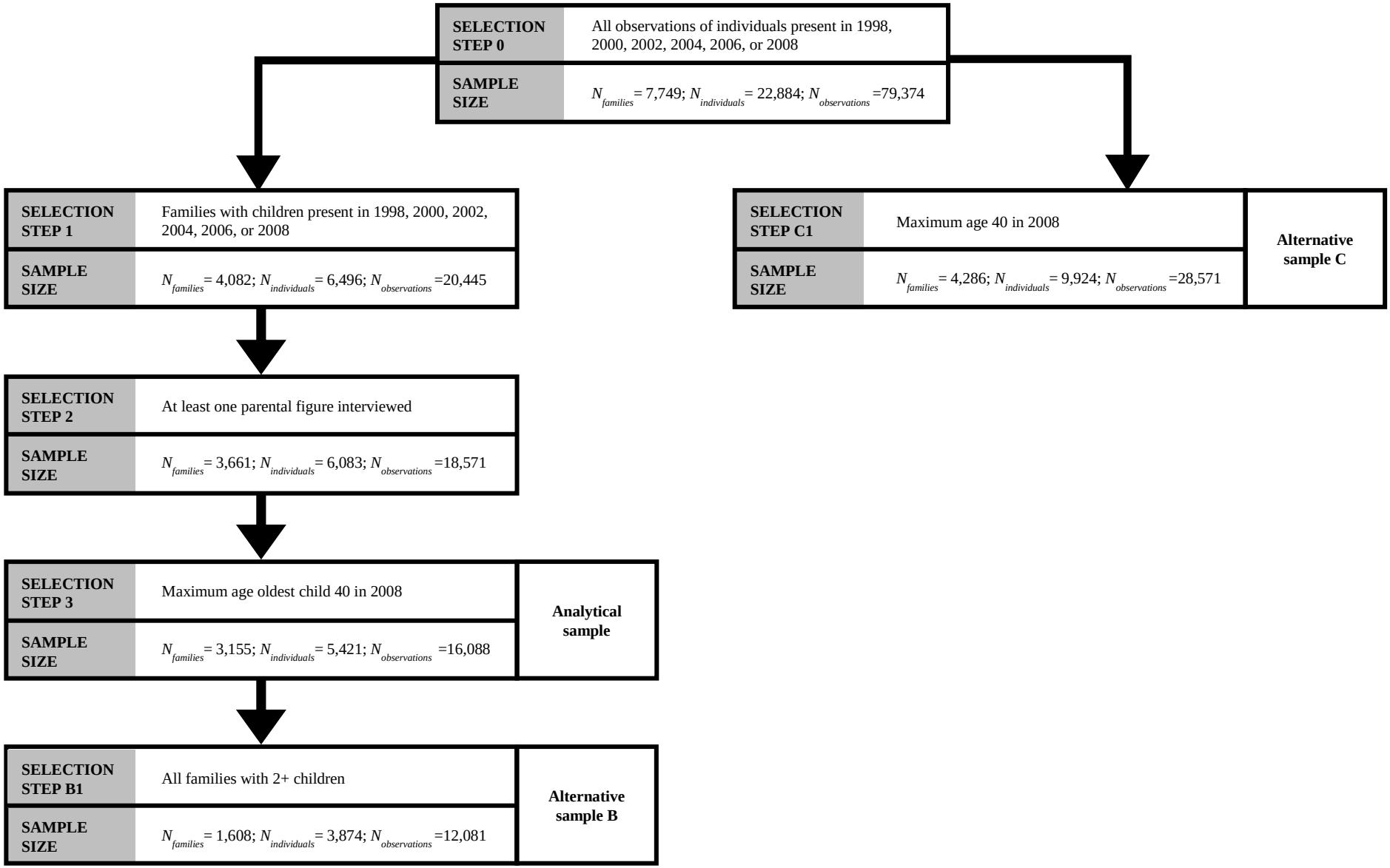

Figure 1. Sample selection steps and sample sizes analytical sample and alternative samples

4. Results

4.1. Descriptive statistics

Descriptive statistics are depicted in Table 1. Averages and proportions are shown for observations in the analytical sample. The average level of acceptance of homosexuality (M = 3.62, SD = 1.19) was about half a point higher than the scale midpoint (3). Observations were equally distributed between men and women. The large majority of respondents (corresponding to 82% of observations) hardly ever attended religious services. Around 41% of observations came from respondents belonging to a religious denomination, the large majority of them (corresponding to 38% of observations) being Christian. Parents were lower educated than their children (mean parental education 2.59 vs 3.64 for that of primary respondents). Religious service attendance of parents was higher than that of children, with 68% of observations belonging to parents hardly ever attending religious services (versus 82% for children), and 22% attending religious services at least once per week (versus 11% for children). In the majority of observations, at least one of both parents identified as Christian (73%). The proportion of observations from families in which one of both parents identified as Muslim or "Other", was low (1% and 3%, respectively). The level of acceptance of homosexuality of parents was about half a point lower than that of primary respondents (mean parental acceptance 3.07 vs 3.62 for that of primary respondents). Only a small proportion of observations came from families with an ethnic minority background (0.04).

Table 1. Descriptive statistics non-imputed data

Variable (range)	Mean (SD) / Proportion	Range	N (% missing)
Time-varying individual characteristics:			
Acceptance of homosexuality	3.62 (1.19)	1 - 5	15,299 (4.9)
Education	3.64 (1.43)	1 - 7	15,365 (4.5)
Left school before age 14, no degree (ISCED 1)	.11		
Left school after age 14, no degree (ISCED 2)	.01		
Secondary education (ISCED 3c)	.39		
Further education (ISCED 3a)	.25		
Higher vocational education (ISCED 5b)	.10		
University bachelor or master (ISCED 5a)	.11		
Doctorate or equivalent (ISCED 6)	.02		
Wave			16,088 (0.0)
1998	.11		
2000	.15		
2002	.17		
2004	.18		
2006	.20		
2008	.20		
Time-constant individual characteristics:			
Birth cohort			16,088 (0.0)
1967-1973	.14		
1974-1983	.51		
1984-1993	.36		
Sex			16,088 (0.0)
Male	.50		
Female	.50		
Religious service attendance			15,802 (1.8)
Practically never/at least once per year	.82		
At least once per month	.07		
At least once per week	.11		
Religious denomination			
No religion	.59		15,426 (4.1)
Christian	.38		
Muslim	.01		
Other	.01		
Time-constant family background characteristics			
Parental education	2.59 (1.67)	1 - 7	16,040 (0.3)
Parental religious service attendance			16,022 (0.4)
Practically never/at least once per year	.68		
At least once per month	.10		
At least once per week	.22		
Parental religious denomination			
No religion	.23		15,922(1.0)
Christian	.73		
Muslim	.01		
Other	.03		
Parental ethnic group membership			16,064 (0.1)
White	.96		
Ethnic minority	.04		
Parental acceptance of homosexuality	3.07 (0.93)	1 - 5	16,017 (0.4)

Note: Proportions may not sum to 1 due to rounding. For education, both mean and proportions are displayed

4.2. Multilevel models

Results of our multilevel and fixed effects regression analyses are depicted in Table 2. We first estimated an empty multilevel model (model 0) to get an indication of the proportions of variance at the different levels. About 23 percent of the total variance was at the family level (.34/(.34+.62+.50)), and roughly 42 percent at the individual (sibling) level (.62/(.34+.62+.50)). Residual variance made up the remaining 35 percent. Model 1 indicates that education was positively associated with acceptance of homosexuality (b=0.13(0.01), p<.001). After controlling for period, cohort and individual background characteristics, the estimated effect of education decreased by about a quarter, but remained positive and significant (b=0.10(0.01), p<.001). In model 3 we additionally controlled for a number of observed family background characteristics. Although each added characteristic was significantly associated with acceptance of homosexuality, the estimated effect of education hardly changed (b=0.09 vs. b=0.10). The same can be said of model four, where we additionally controlled for parental acceptance of homosexuality. The inclusion of this covariate did not affect the estimated effect of education on acceptance of homosexuality (b=0.09(0.01), p<.001). In summary, observed covariates in these multilevel models cannot fully account for the education effect, so there appears to be a non-spurious effect of education on acceptance of homosexuality, in line with hypothesis 1.

Most of the controls in the full model (model 4, Table 2) showed expected effects. The positive period effects indicate that on average, acceptance of homosexuality increased over time. No significant cohort effects were detected, indicating that respondents from younger birth cohorts were not significantly more positive with regard to homosexuality than respondents from older birth cohorts. In addition, women were substantially more accepting of homosexuality than men (b=0.77(0.03), p<.001). With regard to religious service attendance, it was found that only those who attended religious services on a weekly basis were significantly less accepting of homosexuality than those who (almost) never attended religious services (b=-0.42(0.05), p<.001). Controlling for religious service attendance and parental religiosity, respondents identifying as Christian (b=-0.14(0.03), p<.001) and Muslim (b=-0.64(0.25), p<.05) displayed substantially lower levels of acceptance of homosexuality. Respondents with higher educated parents were more accepting of homosexuality. With regard to parental religiosity, respondents with parents that attended religious services at least once per week were less accepting of homosexuality (b=-0.11(0.05), p<.05). Controlling for all other variables in the model, no significant effects were found for parental ethnicity and parental religious denomination. This was likely due to collinearity between these factors and

religious denomination of the child. Strong associations were found between children's and parents' religious denomination. Furthermore, the majority of parents from ethnic minority families belonged to a non-Christian religious denomination (58%), whereas this only was the case for a very small proportion of "White" families (1.7%). The positive effect of parental acceptance of homosexuality indicated that respondents displayed higher levels of acceptance of homosexuality when their parents were more positive about homosexuality. Compared to a model with no predictors (model 0, Table 2), the full model did a fairly good job in explaining variance in acceptance of homosexuality at the family and individual level; about 47% ((.34-.18)/.34) of variance at the family level and about 29% ((.62 - .44)/.62) of variance at the individual level was explained. Note that especially including the direct measurement of parental acceptance of homosexuality increased the explained variance (compare model 3 and 4).

4.3. Fixed effects models

Now we turn to the family and individual fixed effects models that account for all measured and unmeasured time-constant factors that differ between families (model 5) and individuals (model 6). The effect of education on acceptance of homosexuality was only slightly reduced when family fixed effects were included (model 5 versus 4) meaning that education remains important even after taking into account all unobserved family background characteristics (b=0.08(0.01), p<.001). Results from model 5 thus also provide support for hypothesis 1. Fixed effects control for all time-constant confounding factors, both measured and unmeasured. The differences between the estimate of education in models 4 and 5 can thus be interpreted as the part of the effect that is confounded by unmeasured factors at the family level. The small difference suggests that the family background covariates that we included in model 4 captured most of the confounding. In model 6 we included individual fixed effects. Here we see that the estimated effect of education is almost halved compared to the family fixed effects model and only a third of the most naive estimate (model 1), yet it is still positive and significant (b=0.04(0.01), p<.01).

With regard to our hypotheses, the most stringent test indicated that acceptance of homosexuality was (partly) explained by level of education, in line with hypothesis 1. A large part of the education effect was accounted for by family background and individual characteristics, which fits with hypotheses 2 and 3. A comparison of the estimated effect of education on acceptance of homosexuality in the multilevel and fixed effects models can be found in Figure 2 below. Whereas the estimated difference in acceptance of homosexuality

between the lowest (only primary education) and highest (doctorate) educated individual was more than half a scale point in the full multilevel model, this reduced to less than a quarter of a scale point in the individual fixed effects model.

Table 2. Multilevel and fixed effects regressions on acceptance of homosexuality ($N_{families}$=3,155; $N_{individuals}$=5,421; $N_{observations}$=16,088).

		Multilevel models				Family fixed effects	Individual fixed effects
	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Education (centered)		0.13***	0.10***	0.09***	0.09***	0.08***	0.04**
		0.01	0.01	0.01	0.01	0.01	0.01
Wave (1998= ref.)							
2000			0.11***	0.12***	0.12***	0.12***	0.13***
			0.03	0.03	0.03	0.03	0.03
2002			0.22***	0.22***	0.22***	0.23***	0.24***
			0.03	0.03	0.03	0.03	0.03
2004			0.24***	0.25***	0.25***	0.27***	0.27***
			0.03	0.03	0.03	0.03	0.03
2006			0.28***	0.29***	0.29***	0.30***	0.32***
			0.03	0.03	0.03	0.03	0.03
2008			0.36***	0.37***	0.36***	0.38***	0.41***
			0.03	0.03	0.03	0.03	0.03
Birth cohort (1967-1973=ref.)							
1974-1983			0.14**	0.09*	0.06	0.10	
			0.05	0.05	0.04	0.07	
1984-1993			0.08	-0.00	-0.06	-0.00	
			0.05	0.05	0.05	0.08	
Gender (male=ref.)							
Female			0.79***	0.79***	0.77***	0.75***	
			0.03	0.03	0.03	0.03	
Religious service attendance (once per year or less=ref.)							
at least 1x per month			-0.03**	-0.00	-0.06	0.10	
			0.06	0.06	0.05	0.08	
at least 1x per week			-0.47***	-0.41***	-0.36***	-0.22**	
			0.06	0.06	0.15	0.08	
Religious denomination (no religion=ref.)							
Christian			-0.22***	-0.15***	-0.14***		
			0.03	0.03	0.03		
Muslim			-1.08***	-0.64*	-0.64*		
			0.15	0.27	0.25		
Other			-0.26	-0.13	-0.04		
			0.13	0.16	0.15		
Family background characteristics							
Parental education (centered)				0.10***	0.07***		
				0.01	0.01		
Parental religious service attendance (once per year or less = ref.)							
at least 1x per month				-0.02	-0.03		
				0.05	0.05		
at least 1x per week				-0.20***	-0.11***		
				0.05	0.05		
Parental religious denomination (no religion=ref.)							
Christian				-0.12**	-0.05		
				0.03	0.03		
Muslim				-0.19	-0.11		
				0.27	0.26		
Other				-0.10	-0.02		
				0.10	0.10		
Parental ethnic group membership (White=ref.)							
Ethnic minority				-0.19	-0.11		
				0.12	0.11		
Parental acceptance of homosexuality					0.26***		
					0.02		
Constant	3.57***	3.64***	3.06***	3.26***	3.18***	3.02***	3.37***
	0.02	0.02	0.05	0.05	0.05	0.07	0.03

Table 2 (continued). Multilevel and fixed effects regressions on acceptance of homosexuality ($N_{families}$=3,155; $N_{individuals}$=5,421; $N_{observations}$=16,088).

	Multilevel models					Family fixed effects	Individual fixed effects
	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
var(family)	0.34	0.32	0.24	0.23	0.18		
var(child)	0.62	0.60	0.46	0.45	0.44		
var(residual)	0.50	0.50	0.49	0.49	0.49		

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, two-sided.

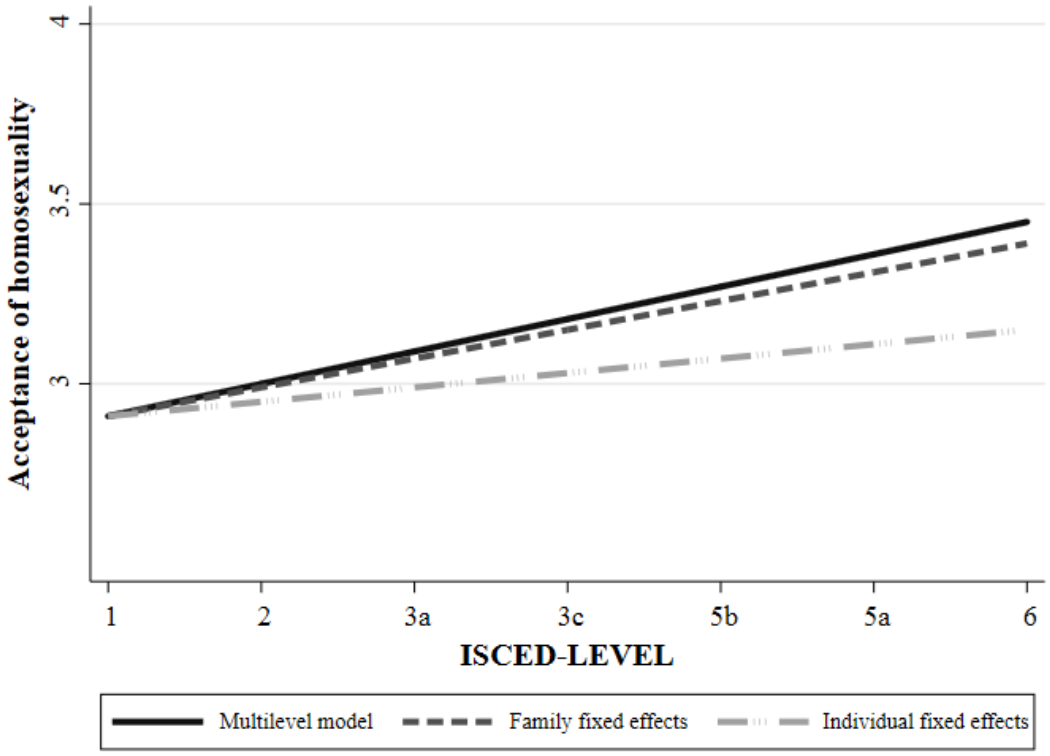

Figure 2. Expected differences in attitude between educational categories

Note: Predicted scores based on models 4, 5, and 6 of Table 2. For sake of comparability we used to same intercept for each line in the Figure (that of the multilevel model, model 4).

4.4 Non-linear education

So far we assumed that the effect of education on acceptance of homosexuality proceeds in a linear fashion. Instead, it could be that certain educational experiences/environments have more/less profound effects. We therefore repeated our analyses and entered education as a set of dummy variables to allow for non-linear effects. Results of these analyses are depicted in Table 3 and Figure 3. Results are fairly consistent with treating education linearly for both the

multilevel and family fixed effects models (models 1-5) and therefore not discussed in detail. Each step up the educational ladder is associated with an increase in acceptance of homosexuality compared to the previous levels, although the estimated effects for further education and higher vocational education are equivalent.

Only results for the individual fixed effects model differ somewhat (model 6, Table 3; Figure 3). Completing secondary or further education was no longer associated with a significant increase in acceptance of homosexuality, compared with completing only primary education. After completing higher vocational education, respondents did become more positive with regard to homosexuality (b=0.31(0.11), p<.01), as well as after obtaining a university level degree (b=0.18(0.09), p<.05). However, the estimated level of acceptance after obtaining a university degree seems lower compared to when people completed higher vocational education (b=.18 vs. b=.31).

Table 3. Multilevel and fixed effects regressions on acceptance of homosexuality, ISCED as dummies ($N_{families}$=3,155; $N_{individuals}$=5,421; $N_{observations}$=16,088).

	Multilevel models				Family fixed effects	Individual fixed effects
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Education (Left school without degree (ISCED 1/2)=ref.)						
Secondary education (ISCED 3c)	0.26***	0.22***	0.18***	0.19***	0.16**	0.07
	0.04	0.04	0.04	0.04	0.05	0.09
Further education (ISCED 3a)	0.48***	0.40***	0.34***	0.34***	0.31***	0.15
	0.04	0.04	0.04	0.04	0.05	0.09
Higher vocational education (ISCED 5b)	0.48***	0.40***	0.35***	0.35***	0.21**	0.31**
	0.05	0.05	0.05	0.05	0.07	0.11
University degree (ISCED 5a/6)	0.68***	0.53***	0.45***	0.46***	0.44***	0.18*
	0.05	0.05	0.05	0.05	0.06	0.09
Wave (1998= ref.)						
2000		0.12***	0.12***	0.12***	0.12***	0.13***
		0.03	0.03	0.03	0.03	0.03
2002		0.22***	0.22***	0.22***	0.23***	0.24***
		0.03	0.03	0.03	0.03	0.03
2004		0.25***	0.25***	0.25***	0.27***	0.27***
		0.03	0.03	0.03	0.03	0.03
2006		0.29***	0.30***	0.29***	0.30***	0.32***
		0.03	0.03	0.03	0.03	0.03
2008		0.36***	0.37***	0.37***	0.37***	0.41***
		0.03	0.03	0.03	0.03	0.03
Birth cohort (1967-1973=ref.)						
1974-1983		0.13**	0.08	0.05	0.09	
		0.05	0.05	0.04	0.07	
1984-1993		0.06	-0.02	-0.07	-0.03	
		0.05	0.05	0.05	0.08	
Gender (male=ref.)						
Female		0.79***	0.79***	0.77***	0.75***	
		0.03	0.03	0.03	0.03	
Religious service attendance (once per year or less=ref.)						
at least 1x per month		-0.04	-0.00	-0.00	0.10	
		0.06	0.06	0.06	0.08	
at least 1x per week		-0.47***	-0.41***	-0.36***	-0.22**	
		0.06	0.06	0.06	0.08	

Tabel 3 (continued). Multilevel and fixed effects regressions on acceptance of homosexuality, ISCED as dummies ($N_{families}$=3,155; $N_{individuals}$=5,421; $N_{observations}$=16,088).

	Multilevel models				Family fixed effects	Individual fixed effects
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Religious denomination (no religion=ref.)						
Christian		-0.21***	-0.15***	-0.14***	-0.07	
		0.03	0.03	0.03	0.05	
Muslim		-1.08***	-0.64*	-0.63*	-0.07	
		0.15	0.28	0.26	0.55	
Other		-0.27	-0.13	-0.04	0.22	
		0.13	0.16	0.15	0.20	
Family background characteristics						
Parental education (centered)			0.09***	0.07***		
			0.01	0.01		
Parental religious service attendance (once per year or less = ref.)						
at least 1x per month			-0.02	0.03		
			0.05	0.05		
at least 1x per week			-0.20***	-0.12***		
			0.05	0.05		
Parental religious denomination (no religion=ref.)						
Christian			-0.12**	-0.05		
			0.03	0.03		
Muslim			-0.19	-0.12		
			0.28	0.26		
Other			-0.10	-0.02		
			0.10	0.10		
Parental ethnic group membership (White=ref.)						
Ethnic minority			-0.19***	-0.11		
			0.12	0.11		
Parental acceptance of homosexuality (centered)				0.26***		
				0.02		
Constant	3.23***	2.75***	2.98***	2.90***	2.78***	3.24***
	0.04	0.06	0.06	0.06	0.08	0.08

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, two-sided.

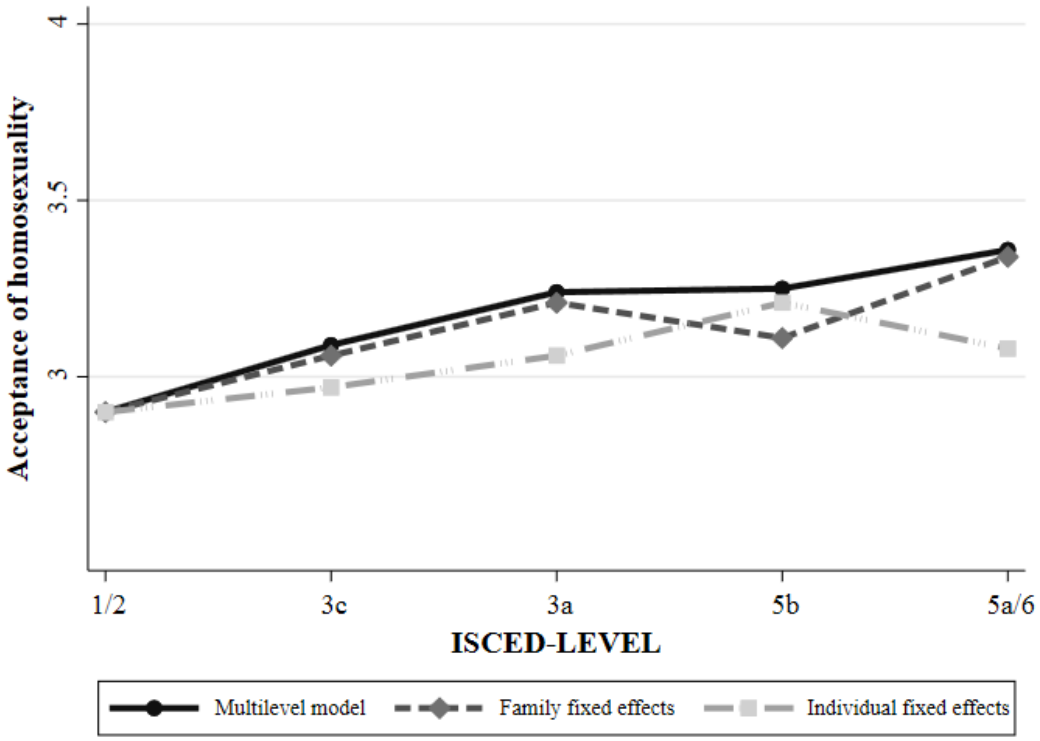

Figure 3. Expected differences in attitude between educational categories, education operationalized as dummies.

Note: Predicted scores based on models 4, 5, and 6 of Table 3. For sake of comparability we used to same intercept for each line in the Figure (that of the multilevel model, model 4).

4.5 Robustness

Results using alternative samples than our default sample can be found in the Appendix. When rerunning the analyses using a sample consisting of all families with at least two children, result of the family fixed effects model reported the same effect for education as our default sample (see Table A.1). The effect of education in the individual fixed effects model was a bit smaller in this sample than in our default sample (b = 0.03, p=.056). Also when operationalizing education as a series of dummies, the effects were very similar to the ones obtained with our default sample (Table A.2). Second, the analyses using all respondents below age forty (Table A.3 and A.4) showed similar findings. The estimated effects of education were very similar to the effects obtained in the default sample. As in our default sample, the individual fixed effects dummy model on this sample also indicated that education beyond higher vocational education was not associated with more acceptance of homosexuality. All in all, our results were robust against employing alternative sample selection strategies.

5. Conclusion and discussion

In this study we contrasted two explanations for the association between education and acceptance of homosexuality. On the one hand there are educational effects explanations, which award a causal influence to education for the development of people's attitudes. Spurious effects explanations, on the other hand, argue that both level of education and acceptance of homosexuality are confounded by family background, and that unobserved individual characteristics could also explain both people's level of education and acceptance of homosexuality. Using family and individual fixed effects regression models, this study showed that family background only partially confounds education and acceptance of homosexuality, suggesting that there is indeed an effect of education on the acceptance of homosexuality.

With regard to the role of (un)observed individual characteristics as potential confounders of the association between level of education and acceptance of homosexuality, a more nuanced conclusion should be drawn. Yes, in general, when people became higher educated over the course of the study they became more accepting of homosexuality. However, when operationalizing level of education as a series of dummies, results indicated that progressing to the summit of the educational system (obtaining a university bachelor or master degree, or a doctorate) did not lead to the highest increase in acceptance of homosexuality. In fact, the highest level of acceptance of homosexuality was found after the obtainment of vocationally oriented higher education, which is not always taught at a university (Schneider, 2008).

This last finding in particular, provides fuel for discussion about existing explanations on the effect of education on the acceptance of homosexuality. One set of explanations argues that education increases acceptance of homosexuality by stimulating 'cognitive sophistication', which leads people in higher education to develop more rational and objective ideas about homosexuality (Lottes & Kuriloff, 1994; Ohlander et al., 2005; Stubager, 2008). The fact that completing university education did not lead people to develop more acceptance of homosexuality could tell us several things about this explanation. First, it could mean that the acceptance of homosexuality through the stimulation of cognitive sophistication is only of importance up to a certain threshold. After this threshold, further stimulation of cognitive sophistication does not make people more accepting of homosexuality. This could explain why within-person change in education is related to more acceptance of homosexuality until

upper secondary/early tertiary education is achieved, but not thereafter. Also, findings from the individual fixed effects model could mean that both acceptance of homosexuality and level of education are partially confounded by levels of cognitive ability and/or sophistication. Especially when interpreting the results of the individual fixed effects model in combination with the results of the family fixed effects model, in which a positive trend with increasing levels of education up until the university level *was* observed. This suggests that unobserved sibling differences (e.g., in cognitive ability) partly explain differences between siblings in both education and acceptance of homosexuality.

Other explanations of the role of education for the acceptance of homosexuality argue that acceptance of homosexuality is stimulated through socializing efforts by teachers and the curriculum (Carvacho et al., 2013; Lambert et al., 2006; Ohlander et al., 2005; Stubager, 2008), as well as through more informal interactions with progressive fellow students and teachers (Patrick et al., 2013; Stubager, 2008). This would lead to the expectation that people become more accepting after obtaining a university degree, since people that obtain a university degree likely are exposed to such progressive socializers for a longer time than those who do not obtain a university degree, or those who never enroll in university education in the first place. The findings of our individual fixed effects models cast doubt on the validity of these mechanisms, at least within the UK context. One tentative explanation for this could be that many people have already passed their 'formative phase' with regard to socio-political attitudes before they enter university, meaning that their attitudes have largely stabilized and will not change much over the course of university education. In line with this, some studies indicate that people already show high levels of stability in acceptance of homosexuality and other socio-political attitudes by their late teens (Alwin & Krosnick, 1991; Hooghe & Meeusen, 2012; Hooghe & Wilkenfeld, 2008).

The difference in effect size of education between our family fixed effects and individual fixed effects models also provide an interesting starting point for future research. The fact that the estimate for the individual fixed effects model is about half that of the family fixed effect model, suggests that there are confounding factors at the individual level, not measured in this study. One interesting avenue for future research could thus entail searching for individual characteristics (e.g. cognitive ability, openness to change) that could explain both differences in education and acceptance of homosexuality between siblings. Likewise, studies could be conducted on differences in social/environmental factors that could bring about sibling differences in acceptance of homosexuality, such as differential influences of peers in friendship groups.

Furthermore, although our results showed that education and other personal and family level characteristics served as significant predictors of acceptance of homosexuality, a substantial part of variance was left unexplained. Interesting avenues for further research might be to look for explanations of acceptance of homosexuality outside the well-known socio-demographic correlates and even the family context. For example, recent research has drawn attention to the potential effect of (selective) social media usage on opinion formation (Bakshy, Messing, & Adamic, 2015). It would be an interesting question for future research to study if and how (social) media has influenced acceptance of homosexuality in recent times.

This study was not without limitations. One limitation of the data is the low amount of ethnic minorities available in our sample, which has been a problem recognized regarding the BHPS (Berthoud, Fumagalli, Lynn, & Platt, 2009). We argue that the unique strengths of the BHPS (multiple siblings covered for a long period of time) make this study of great interest nonetheless. The dependent variable was measured using a single item ("homosexual relationships are wrong"). This is not ideal but common in the field (Andersen & Fetner, 2008; Keleher & Smith, 2012; Van den Akker et al., 2013). Nevertheless, we believe that the merits of the BHPS mentioned earlier made it a sample worth using for the purpose of this study. Relatedly, the dependent variable being a single item might make readers question our choice for linear models. We feel however that the usage of linear models was the optimal solution for achieving the purpose of this study: comparing the effect of education on acceptance of homosexuality across different model specifications. One the one hand, comparing effect sizes across model specifications is more straightforward in a linear framework than in logistic or probit models, which would have necessitated the comparison of average marginal effects (AMEs) (Mood, 2010). AMEs are however not straightforwardly comparable between mixed and fixed effects models (Buijs, 2012). On the other hand, we could to a large extent compensate for the three problems that arise when applying a linear model on limited dependent variables. Heteroscedasticity of errors (1) was compensated for by using robust standard errors (StataCorp, 2017), whereas out of range predicted values (2) hardly occurred in our models. Potential nonlinearity in the association (3) was partly taken into account by estimating models that operationalized education as a series of dummies. We say partly, as these models still treated acceptance of homosexuality as a continuous construct. However, average marginal effects (AMEs), which would have been used alternatively, also ignore the nonlinearity of the relationship between dependent and independent variables (Mood, 2010).

This study was carried out in the UK between 1998-2008, which was a period of increasing legalization of same-sex marriage in many Western countries. Shortly after the period covered in this study, same-sex marriage was introduced in England, Wales[4], and Scotland[5]. Consequently, homosexuality might have become more universally accepted in the UK than was the case in 2008. As a result, the positive effect of education on the acceptance of homosexuality might have decreased compared to the time at which the data from our study was collected. This being said, recent reports find that violence against LGBT people is a frequent occurrence in the UK, casting doubt on the universality of the acceptance of homosexuality (Bachmann & Gooch, 2017).

Furthermore, it should be kept in mind that our findings may not be easily generalizable to other countries than the UK. For example, the British landscape of higher education institutions is fairly different from that of most other Western European countries. Most importantly, the United Kingdom in general and England and Wales in particular, contain a large number of elitist high schools and universities, which can only be entered by paying sizable tuition fees. Students of lower socio-economic and ethnic minority background are substantially underrepresented within these institutions (Boliver, 2013; Whitty, Hayton, & Tang, 2015). One of the mechanisms through which higher education is supposed to lead to higher acceptance of homosexuality, is through students being introduced to a large diversity in terms of ideas and lifestyles within higher education institutions (Andersen & Fetner, 2008; Lambert et al., 2006; Lottes & Kuriloff, 1994). This mechanism might operate less strongly within elitist institutions, as its student population is fairly homogenous in terms of socio-economic and ethnic background. As a result, the association between education and acceptance of homosexuality might be weaker in the UK than in other Western European countries, where such elitist institutions do not exist or comprise a smaller part of the educational system.

In conclusion, this study investigated whether increased education leads to higher levels of acceptance of homosexuality, or whether this association is confounded. We found that about one third of the association between acceptance of homosexuality and education was confounded by family background and observed individual characteristics. An additional one-third of the association was confounded by stable unobserved individual characteristics. Yet, a positive and significant association between the two was still found. Together these

[4] https://en.wikipedia.org/wiki/Marriage_(Same_Sex_Couples)_Act_2013
[5] https://en.wikipedia.org/wiki/Marriage_and_Civil_Partnership_(Scotland)_Act_2014

models suggest that education affects acceptance of homosexuality, although a substantial part of the association is confounded by family background and individual characteristics.

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Appendix: Alternative analytical samples

Table A.1:
- Alternative sample B: sample restricted to families with two or more children
- education linear

Table A.2:
- Alternative sample B: sample restricted to families with two or more children
- education non-linear (dummies)

Table A.3:
- Alternative sample C: sample of all individuals below 40
- education linear

Table A.4:
- Alternative sample C: sample of all individuals below 40
- education non-linear (dummies)

Table A.1. Multilevel and fixed effects regressions on acceptance of homosexuality, families with two or more children ($N_{families}$=1,608; $N_{individuals}$=3,874; $N_{observations}$=12,081).

	Multilevel models					Family fixed effects	Individual fixed effects
	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Education (centered)		0.13***	0.09***	0.08***	0.08***	0.08***	0.03
		0.01	0.01	0.01	0.01	0.01	0.02
Wave (1998= ref.)							
2000			0.13***	0.13***	0.13***	0.13***	0.14***
			0.03	0.03	0.03	0.03	0.03
2002			0.21***	0.22***	0.21***	0.21***	0.23***
			0.03	0.03	0.03	0.03	0.03
2004			0.24***	0.25***	0.24***	0.26***	0.27***
			0.03	0.03	0.03	0.03	0.03
2006			0.31***	0.31***	0.31***	0.31***	0.35***
			0.03	0.03	0.03	0.04	0.04
2008			0.38***	0.39***	0.38***	0.39***	0.43***
			0.03	0.03	0.03	0.04	0.04
Cohort (1967-1973=ref.)							
1974-1983			0.13*	0.09	0.06	0.10	
			0.06	0.06	0.06	0.07	
1984-1993			0.05	-0.01	-0.06	-0.00	
			0.06	0.06	0.06	0.08	
Gender (male=ref.)							
Female			0.79***	0.79***	0.77***	0.75***	
			0.03	0.03	0.03	0.03	
Religious service attendance (once per year or less=ref.)							
at least 1x per month			-0.01*	0.01	0.01	0.10	
			0.07	0.07	0.07	0.07	
at least 1x per week			-0.39***	-0.34***	-0.30***	-0.22**	
			0.07	0.07	0.07	0.08	
Religious denomination (no religion=ref.)							
Christian			-0.18***	-0.13**	-0.12**	-0.07	
			0.04	0.04	0.04	0.05	
Muslim			-1.17***	-0.69*	-0.67*	-0.12	
			0.16	0.35	0.32	0.51	
Other			-0.21	-0.10	0.03	0.21	
			0.17	0.22	0.21	0.19	
Family background characteristics							
Parental education (centered)				0.09***	0.06***		
				0.01	0.01		
Parental religious service attendance (once per year or less = ref.)							
at least 1x per month				-0.03	-0.00		
				0.07	0.06		
at least 1x per week				-0.22***	-0.13***		
				0.06	0.06		
Parental religious denomination (no religion=ref.)							
Christian				-0.07	-0.00		
				0.04	0.04		
Muslim				-0.17	-0.10		
				0.34	0.32		
Other				-0.02	0.05		
				0.14	0.14		
Parental ethnic group membership (White=ref.)							
Ethnic minority				-0.18	-0.10		
				0.17	0.15		

Tabel A.1 (continued). Multilevel and fixed effects regressions on acceptance of homosexuality, families with two or more children ($N_{families}$=1,608; $N_{individuals}$=3,874; $N_{observations}$=12,081).

	Multilevel models					Family fixed effects	Individual fixed effects
	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Parental acceptance of homosexuality (centered)					0.27***		
					0.02		
Constant	3.56***	3.63***	3.04***	3.18***	3.12***	3.01***	3.35***
	0.02	0.02	0.06	0.07	0.07	0.07	0.03

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, two-sided.

Tabel A.2. Education as dummy, all families with two or more children ($N_{families}$=1,608; $N_{individuals}$=3,874; $N_{observations}$=12,081).

	Multilevel models				Family fixed effects	Individual fixed effects
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Education (Left school without degree (ISCED 1/2)=ref.)						
Secondary education (ISCED 3c)	0.25***	0.20***	0.17**	0.18***	0.17**	0.05
	0.05	0.05	0.05	0.04	0.05	0.10
	0.46***	0.37***	0.32***	0.33***	0.32***	0.12
Further education (ISCED 3a)	0.05	0.05	0.05	0.05	0.05	0.10
	0.45***	0.34***	0.30***	0.31***	0.20**	0.32*
Higher vocational education (ISCED 5b)	0.06	0.06	0.06	0.06	0.07	0.12
University degree (ISCED 5a/6)	0.67***	0.48***	0.41***	0.43***	0.44***	0.13
	0.06	0.06	0.06	0.06	0.06	0.10
Wave (1998= ref.)						
2000		0.13***	0.13***	0.13***	0.13***	0.14***
		0.03	0.03	0.03	0.03	0.03
2002		0.22***	0.22***	0.22***	0.21***	0.23***
		0.03	0.03	0.03	0.03	0.03
2004		0.25***	0.25***	0.25***	0.26***	0.27***
		0.03	0.03	0.03	0.04	0.03
2006		0.31***	0.32***	0.31***	0.31***	0.35***
		0.03	0.03	0.03	0.04	0.04
2008		0.39***	0.39***	0.39***	0.39***	0.43***
		0.03	0.03	0.03	0.04	0.04
Cohort (1967-1973=ref.)						
1974-1983		0.11	0.08	0.05	0.09	
		0.06	0.06	0.06	0.07	
1984-1993		0.02	-0.03	-0.08	-0.03	
		0.06	0.06	0.06	0.08	
Gender (male=ref.)						
Female		0.78***	0.78***	0.77***	0.75***	
		0.03	0.03	0.03	0.03	
Religious service attendance (once per year or less=ref.)						
at least 1x per month		-0.02*	0.00	0.00	0.10	
		0.07	0.07	0.07	0.07	
at least 1x per week		-0.40***	-0.34***	-0.30***	-0.22**	
		0.07	0.07	0.07	0.08	
Religious denomination (no religion=ref.)						
Christian		-0.18***	-0.13**	-0.12**	-0.07	
		0.04	0.04	0.04	0.05	
Muslim		-1.16***	-0.69	-0.66*	-0.07	
		0.16	0.35	0.33	0.53	
Other		-0.21	-0.09	0.03	0.22	
		0.18	0.22	0.21	0.20	
Family background characteristics						
Parental education (centered)			0.09***	0.06***		
			0.01	0.01		
Parental religious service attendance (once per year or less = ref.)						
at least 1x per month			-0.03	-0.00		
			0.07	0.06		
at least 1x per week			-0.21***	-0.13*		
			0.06	0.06		
Parental religious denomination (no religion=ref.)						
Christian			-0.07	-0.01		
			0.04	0.04		
Muslim			-0.17	-0.10		
			0.34	0.32		
Other			-0.02	0.05		
			0.14	0.14		

Tabel A.2 (continued). Education as dummy, all families with two or more children ($N_{families}$=1,608; $N_{individuals}$=3,874; $N_{observations}$=12,081).

	Multilevel models				Family fixed effects	Individual fixed effects
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Parental ethnic group membership (White=ref.)						
Ethnic minority			-0.18***	-0.10		
			0.17	0.16		
Parental acceptance of homosexuality (centered)				0.27***		
				0.02		
Constant	3.23***	2.76***	2.94***	2.86***	2.78***	3.24***
	0.05	0.07	0.08	0.08	0.08	0.09

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, two-sided.

Table A.3 and A.4, all individuals younger than 40

For alternative sample C, which included observations of all individuals younger than 40, the nesting construction was slightly different compared to the default sample. Family nesting was taken into account by creating a grouping variable assigning people to the same group ("family" or "household") when they had ever lived together. In addition, all observed individuals are treated as units of analysis in this sample (including 'children' as well as 'parents'), so the family background variables could not be constructed for all respondents. Consequently, we only repeated the analyses for models 1, 2, 5 and 6.

Tabel A.3. Multilevel and fixed effects models, all individuals below 40 ($N_{families}$=4,286; $N_{individuals}$=9,924; $N_{observations}$=28,571).

	Multilevel models		Family fixed effects	Individual fixed effects
	Model 1	Model 2	Model 5	Model 6
Education (centered)	0.13***	0.11***	0.08***	0.04***
	0.01	0.01	0.01	0.01
Wave (1998= ref.)				
2000		0.11***	0.11***	0.12***
		0.02	0.02	0.02
2002		0.16***	0.18***	0.19***
		0.02	0.02	0.02
2004		0.20***	0.22***	0.24***
		0.02	0.03	0.02
2006		0.23***	0.24***	0.27***
		0.02	0.02	0.02
2008		0.28***	0.30***	0.33***
		0.02	0.02	0.02
Cohort (1967-1973=ref.)				
1974-1983		0.13***	0.09**	
		0.03	0.03	
1984-1993		0.14***	0.09*	
		0.03	0.04	
Gender (male=ref.)				
Female		0.68***	0.64***	
		0.02	0.02	
Religious service attendance (once per year or less=ref.)				
at least 1x per month		-0.12**	-0.02	
		0.04	0.05	
at least 1x per week		-0.59***	-0.33***	
		0.04	0.06	
Religious denomination (no religion=ref.)				
Christian		-0.20***	-0.10**	
		0.02	0.03	
Muslim		-1.13***	-0.55	
		0.14	0.29	
Other		-0.24*	-0.01	
		0.10	0.13	
Constant	3.62***	3.15***	3.11***	3.41***
	0.01	0.03	0.03	0.02

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, two-sided.

Tabel A.4. Education as dummies, all individuals below forty ($N_{families}$=4,286; $N_{individuals}$=9,924; $N_{observations}$=28,571).

	Multilevel models		Family fixed effects	Individual fixed effects
	Model 1	Model 2	Model 5	Model 6
Education (Left school without degree (ISCED 1/2)=ref.)				
Secondary education (ISCED 3c)	0.23***	0.20***	0.15***	0.06
	0.03	0.03	0.03	0.07
Further education (ISCED 3a)	0.45***	0.40***	0.30***	0.16*
	0.04	0.03	0.04	0.07
Higher vocational education (ISCED 5b)	0.45***	0.41***	0.24**	0.26**
	0.04	0.04	0.04	0.09
University degree (ISCED 5a/6)	0.65***	0.58***	0.44***	0.21**
	0.04	0.04	0.04	0.08
Wave (1998= ref.)				
2000		0.11***	0.11***	0.12***
		0.02	0.02	0.02
2002		0.16***	0.18***	0.19***
		0.02	0.02	0.02
2004		0.20***	0.22***	0.24***
		0.02	0.02	0.02
2006		0.23***	0.24***	0.28***
		0.02	0.02	0.02
2008		0.28***	0.30***	0.33***
		0.02	0.02	0.02
Cohort (1967-1973=ref.)				
1974-1983		0.12***	0.09**	
		0.03	0.03	
1984-1993		0.12***	0.07	
		0.03	0.04	
Gender (male=ref.)				
Female		0.68***	0.64***	
		0.02	0.02	
Religious service attendance (once per year or less=ref.)				
at least 1x per month		-0.13***	-0.02	
		0.04	0.05	
at least 1x per week		-0.59***	-0.33***	
		0.05	0.06	
Religious denomination (no religion=ref.)				
Christian		-0.20***	-0.10**	
		0.02	0.03	
Muslim		-1.22***	-0.54	
		0.13	0.29	
Other		-0.24*	-0.01	
		0.10	0.13	
Constant	3.24***	2.82***	2.87***	3.27***
	0.03	0.04	0.04	0.06

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, two-sided.